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ABSTRACT

This study assesses the ability of schema theory to address ill-structured problems without becoming unwieldy. Prior to addressing the study proper, the paper reviews the literature on memory for complex phenomena, ill-structured problems, expert-novice differences, administration as problem solving, and assessment of complex learning outcomes. Study subjects included 31 elementary school principals (representing a full range of experience) recruited from six moderate to large county school boards in southern Ontario, Canada. The study design involved group discussions, fact finding, thinking aloud, and a case study review involving problem solving. The case study presented a conflict between a school staff and school librarian and involved elements of supervision, curriculum, policy, interpersonal relations, physical plant, budget and supply, and staff attitudes. The schema procedure involved construction of a collective story line, across subjects, capturing the variety of responses to the problem, including values exhibited, perspectives taken, and actions planned. Within this collective framework, individual responses to the problem can be highlighted. Results raise the question of whether these methods can be applied to assessment of outcomes of schooling including written as well as verbal student output. The case study, a narrative version of the schema, and six data tables are included. (TJH)

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Modelling Ill-Structured Problem Solving with Schema Theory¹

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Introduction

The purpose of this report is to explore an extension of schema theory as a method of analyzing solutions to an ill-structured problem. The immediate perspective taken is from cognitive science, while the long-term perspective is from applied measurement, specifically from work on methods of assessing complex behaviour. Issues in the administration of schools serve as a vehicle for exploration of methodological concerns. Although the context for the study is adults responding to a case study, the implications of the method extend to student responses to a variety of stimuli designed to assess some of the more complex (i.e., "higher order") outcomes of education.

The objectives of this report are:

1. To present a methodology for the analysis and comparison of responses to an ill-structured social problem.
2. To examine the potential of these methods to reveal differences in subject responses related to experience and expertise.
3. To discuss issues in the application of the methods.

The results reported herein are an extension and elaboration of one aspect of Nagy, Allison, Allison & Moorhead (1990). Subjects varying in experience in the elementary school principalship were presented with a case study which related a typical problem that might face a principal in his/her working day. Responses to this task were analyzed using a method:

- (a) based initially on the work of Voss (Voss, Greene, Post & Penner, 1983),
- (b) refined through a series of exploratory studies (see Nagy, Allison, Allison & Moorhead, 1990), and
- (c) extended through application of rating scales based on the work of Biggs and Collis (1982).

Both schema theory and the concept of an ill-structured problem have evolved in recent years as the interests of researchers in memory and problem solving have turned to complex phenomena. To date, most work on ill-structured problems has been based on adaptations of and analogies to artificial intelligence, in the form of production rules and flowchart-like portrayals. Schema theory offers a potentially profitable alternative. The essence of the procedure is to build a collective story-line, across subjects, capturing the variety of responses to the problem, including values exhibited, perspectives taken, and actions planned. Within this collective framework, then, individual responses to the problem can be highlighted and compared. The motivation for this particular study stems from the inability of schema theory to capture sufficient detail in problem solutions without becoming unwieldy.

Literature

The literature forming the background to this study comes from several sources. Among these are work on memory for complex phenomena, the solution of ill-structured problems, expert-novice differences, problem solving in school administration, and assessment of complex learning outcomes. As more detailed discussion is available in earlier writings (Nagy and Allison, 1988; Allison and Nagy, 1989; Nagy and Moorhead, 1990) I present here only a brief overview.

Memory for Complex Phenomena

Researchers have posited several varieties of complex entities as organizing principles in attempting to understand memory for stories and sequences of events. Anderson, Spiro and Anderson (1978) describe schema theory, one version of such an organizing principle. Schemata act as mental structures; they incorporate general knowledge, and are more abstract than the particulars

of a given situation. Interpretation of memory data involves matching elements in a specific situation to generic slots or placeholders. They report a study in which subjects read a restaurant story and a grocery-store story involving purchase of the same foods. The expectation was that the subjects' internal restaurant schemata, the expectations of the sequence and content of courses served in a fine restaurant, would impose structure on memory and result in an increase in memory for the foods mentioned. The results confirmed their expectation, and support the hypothesis that complex material is stored by complex mechanisms.

Cognitive theorists have debated the psychological status of schemata. Alba and Hasher (1983) argue that the evidence shows that stored memories are richer than the selected subset predicted by schema theory. This suggests that it is appropriate to view schema theory as a method of imposing order on complexity, not necessarily involving any strong assumptions concerning the nature of human memory. This perspective, adopted here, gives the method the status of a portrayal technique, an heuristic device useful for imposing order on data.

As a device for imposing order and examining differences, schema theory holds promise. For example, Schallert (1982) notes that schemata evolve; that is, they become more elaborate and specific with experience. This suggests that an examination of the details of story-lines across individuals might be used to highlight differences in specificity or sophistication, differences which in turn might be linked to experience or expertise.

There is a difficulty with such a perspective, however: how to decide what constitutes a more complete or more sophisticated version of a schema. For example, Horton and Mills (1984) reviewed the literature on human learning from

a schemata perspective, using a levels-of-processing framework. They concluded that such an approach is plagued by the lack of an independent definition of depth of processing. Thus, a present limitation to the technique is reliance on subjective decisions concerning the adequacy or quality of particular pieces of data. In this project, we have dealt with this difficulty in two ways: first, we have used a panel of expert judges to rate quality of our subjects' responses; second, we have adapted Biggs and Collis' "structure of learning outcomes" scale to assess the complexity of respondents' productions.

Ill-Structured Problems

Frederiksen (1984) summarized Simon's original distinction between well-structured and ill-structured problems. The characteristics of ill-structured problems include greater complexity, less definite criteria for deciding if a solution has been reached, lack of complete information, absence of a "legal move generator", and no convenient list of accepted procedures. They also have higher verbal content and are more context dependent. Most "real-life" problems would be classified as ill-structured.

Methods for the analysis of ill-structured problems have evolved from the production rule or flowchart methods designed for well-structured ones (e.g., logic puzzles, chess). Voss and Post (1988) noted that the method chosen for the analysis of ill-structured problems reflects the theoretical concerns of the investigators. A variety of approaches has been developed to meet various concerns. For example, Larkin (1980), working with physics and algebra problems, has found that large-scale units are useful in the analysis of problem solving in such domains. Voss, Greene, Post & Penner (1983), investigating how subjects would deal with the lack of productivity of the Soviet agricultural system, categorized statements as pertaining to goals or reasoning. Goal statements dealt

with relatively global moves such as identification of major issues and subproblems, while reasoning statements dealt with the analysis within the structure of these subproblems. Finally, Lawrence (1988), in the context of judicial decision making, developed a model using elaborate if... then statements, in an attempt to capture a priori perspectives ("frames of reference"), which correspond, according to Voss and Post (1988), to the magistrates' courtroom schemata.

Expert-Novice Differences

Glaser and Chi (1988) have provided a survey of the literature on expert-novice differences in a large variety of problem solving contexts. Within the ill-structured framework, Voss et al (1983) demonstrated general characteristics of expert solutions: experts did not articulate their highest level plans; they did not speak of a general solution strategy; they did not begin with a well-developed plan, but developed one in reviewing the problem; expert plans could be classified as either problem conversion (to one they could solve) or problem decomposition; experts tried for one general solution to solve the problem, using a lot of reasoning; novices tended to deal with low level subproblems and use little reasoning. In solution activity, only experts examined the implications of their solutions. Experts spent a lot of time on argumentation.

Administration as Problem Solving

Two lines of research have examined the school principalship from a problem solving perspective. From an administrative perspective, Leithwood and Stager (1986) reported differences in principals' sorting of problems, their solution strategies, and the influences on their strategies and priorities. Their results showed that better principals use group solutions more often, and in different ways; they emphasise programs over buildings and relationships, and give fuller

rationales. Better principals tackle fundamental rather than superficial problems, are more reflective and seek clarification more, and list more specific sources of information. Better principals are aware of "problem solving" as a definite activity and they enjoy it and are confident at it.

Leithwood and Stager (1987) analyzed expert and non-expert protocols on school problems, finding similarities in the two groups on clear problems and differences on unclear ones. In the latter, nonexperts had more interpretation statements, and fewer goals and solution processes. The experts thought of school and system consequences; nonexperts thought of personal consequences. Experts expressed belief in the power of rational thought; nonexperts didn't. Experts were more specific in statements and assumptions, and cited more relevant anecdotes. Experts planned more; nonexperts paid little attention to planning.

The present report is one in a series that has taken a cognitive rather than administrative perspective on principals' problem solving; more detail can be found in Nagy, Allison, Allison and Moorhead (1990). Briefly, and with the benefit of hindsight, the following points of progress guide the present methodology:

First, simulations differ from real-world scenarios. Cases are limited in length and complexity while, for example, in Voss' Soviet agriculture problem, respondents are limited only by their own knowledge. Different patterns of reasoning emerge, and different category systems are required. (Nagy and Allison, 1988).

Second, content-free counts of abstracted statement types (e.g., reasoning, action) do not alone capture differences in quality. In addition, content-based categories (e.g., individuals consulted, information sought, specific actions taken) are required (Nagy and Moorhead, 1990).

Third, in addition to the usual think-aloud training (Ericsson & Simon, 1984), substantial stage-setting and probing of subjects is required to deal with "things left unsaid" and individual differences in speaking style (Allison and Nagy, 1989).

Fourth, simulations, and ill-structured problems in general, vary in their degree of structure. Schema theory will be more useful for more complex problems such as the present, and of limited application to simple problems such as "what would you do if..." (Nagy, 1990).

Fifth, as Alba & Hasher (1983) suggest, schema theory cannot capture all worthwhile detail of case study responses. If, in building of the schema, sub-category formation stops at a manageable level, the placeholders or categories do not demarcate all useful differences across responses (Nagy, Allison, Allison & Moorhead, 1990).

Assessment of Complex Learning Outcomes

Although this particular study does not deal with student response to learning, one of the goals of the larger research program is student assessment in complex areas. It is increasingly recognized that the more complex goals of education lack appropriate assessment methods (Archbald and Newmann, 1988). Despite the advantages of schema theory in dealing with complexity, there is a limitation. For example, the schema developed for the present study was structured into as many as five hierarchical levels, but still failed to capture a satisfying level of detail in the content of what was said. Statements revealing vastly different degrees of insight and complexity were categorized together, but attempts to subdivide categories further became unwieldy and were abandoned.

One possible solution to this difficulty lies in an adaptation of the work

of Biggs and Collis (1982), who have identified five levels of response to tasks presented to students. Although they limit their work to problems with enough structure for there to be known answers, it appears relatively easily adaptable to the case under investigation.

Each of these five levels is described with respect to memory capacity, mental operations used, consistency of reasoning and nature of closure brought to the question. In terms of structural complexity, they describe their levels, from lowest to highest, as follows.

1. Prestructural responses work from irrelevant or erroneous data to one response.
2. Unistructural responses work from one relevant and given datum to one response.
3. Multistructural responses work from several relevant and given data to one response.
4. Relational responses generalize within the given data to produce one response.
5. Extended abstract responses generalize within both given and hypothetical data and produce or allow for more than one response.

In the present study, the utility of a modified version of this scale was investigated.

Method

Subjects

Subjects were chosen from volunteers recruited from six moderate to large-sized county school boards in southern Ontario. The sampling plan called for eight subjects from each of four experience levels in the elementary school

principalship: Aspirant (0 years), Novice (1-2 years), Seasoned (10-15 years) and Veteran (20 plus years). (In the discussion and tables that follow, these are sometimes referred to as Levels 1 through 4.) Three transcripts were lost, but in two cases, this was discovered in time for the subject and interviewer to attempt a joint reconstruction of the case solution. Thus, there are data from 31 subjects, 8, 8, 7, and 8 respectively, from the four experience levels. Half the inexperienced group were female; the remaining 27 were all male.

Data Collection

Subjects in groups of four spent a day with the research team. They participated in a group discussion, responded individually to a related fact-finding activity and to the case study, filled out several paper-and-pencil instruments, and were interviewed extensively. Only the case study results are reported here.

Each group began with a 30 minute warm-up and group discussion, and then individual research team members each took one subject. These individual sessions began with a fact finding activity in which subjects were told they would be asked to deal with a case, and were then allowed to ask whatever questions they wished about the school setting that formed part of the case. Next, subjects undertook training in the think aloud process using suggestions from Ericsson and Simon (1984), and then went on to the case study. First, subjects were asked to read the case aloud, interjecting their thoughts as they read. Then, they were asked to think aloud about how they would solve the process. Finally, they were asked to recall their thought processes.

The degree of separation between reading and solving varied across subjects, as did the degree of thoroughness with which the final recall was treated. The process took between 50 and 100 minutes for each subject.

The Case

The presented case describes a conflict between a school staff and school librarian. The situation, presented in the story to a principal new to the building, involves elements of supervision, curriculum, policy, interpersonal relations, physical plant, budget and supply, and staff attitudes. The librarian is Miss MacDonald, the principal is Pat Jones, and the other named protagonist is Miss Green, a first-year teacher. The full case appears as Appendix A.

Analysis

The Schema

The essence of the procedure used to analyze the data is to build a collective story-line, across subjects, capturing the variety of responses to the problem, including values exhibited, perspectives taken, and actions planned. Within this collective framework, then, individual responses to the problem can be highlighted and compared. An earlier version of this collective story-line or schema was initially reported in Nagy, Allison, Allison and Moorhead (1990). Issues encountered with that analysis, leading to the extension reported here, can be briefly summarized:

First, segmentation of the protocol into units for analysis, determination of when one thought unit ends and another begins, depends on striking a balance between capturing detail and producing a manageable category system.

Second, organization of the category system can facilitate its use. Seven major areas of problem content arose from the case, but many categorization decisions were difficult. Difficulties were minimized by organizing the categories from more global (the problem solving process) to more specific

areas (the librarian). It was a more precise and less taxing task to postpone categorization only when a statement clearly fit a smaller category than to postpone when the statement only fit a larger category. Third, as mentioned above, a hierarchical category system becomes unwieldy before all data elements in a single category are sufficiently homogeneous to distinguish levels of experience and expertise in the data set.

The Ratings

Assigning statements to levels of the schema alone did not capture sufficient detail; an additional analysis was developed to deal with this issue. This system, modelled on Biggs and Collis (1982), uses a 4-point scale to rate the amount of information dealt with by each subject within the statements assigned to each schema category:

- 1: makes one or two points without supporting argument or elaboration
- 2: makes one or two points with supporting argument or elaboration
- 3: makes two points and relates them to each other with supporting argument or elaboration
- 4: makes more than two points and relates them to each other with supporting argument or elaboration.

The interpretation of these definitions varied with the nature of the schema category. In particular, it was not always clear whether the rating scale addressed quality or quantity. Certainly, there were times when the quality of what was said was not captured by the system. There were other times when simple quantity (i.e., number of ideas) was misleading, particularly if the subject simply listed several unrelated points. In practice the counting of "points" from the above definitions sometimes took second place to the following retrospectively reconstructed implicit definitions:

- 1: just mentioned in passing
- 2: making a routine point or observation
- 3: synthesizing several ideas with evidence of thought
- 4: marshalling a major argument or rationale.

The Reporting

The reporting in this paper covers six issues: first, the collective schema for the problem solution; second, the relationship between statement rating levels and experience; third, the relative emphasis within the schema as a function of experience; fourth, how the schema differentiates across experience; fifth, how the schema differentiates across expertise; and sixth, how the ratings differentiate across expertise.

Results

The Schema

Segmentation and categorization of the 31 transcripts, followed by hierarchical organization of the category system, produced the schematic representation displayed in Table 1. The narrative version of the schema, produced from the detailed classification system, conveys better than the tabular display an overall flavour of the collective approach of the respondents. Readers with an interest in the substantive issues of the case are referred to Appendix B.

Insert Table 1 about here

The focus of much of the rest of this report is on the methodological issues raised by the analysis, and on the potential of such methods for

examination of complex problem solving. Discussion of these issues cannot take place in the abstract, however, and some detail concerning the administration of schools is included.

The reliability of statement categorizations was checked by having two independent raters categorize all the statements from a randomly-chosen two of the 31 subjects. Consistency was not as high as might be hoped for. All three raters agreed exactly in only 43% of the cases, but this figure rises to 56% if the criterion is agreement on the first two digits of the categorization. If we look for agreement between any two of the three raters, the figure for perfect agreement is 72%, and for agreement to two digits, 86%. This analysis was done with little training and no discussion, and thus represents a lower estimate of the reliability possible with this type of analysis.

The Ratings

One rating on the 4-point scale was assigned to each set of statements made by one respondent categorized as belonging to the same schema category. Table 2 summarizes the numbers of each statement type as a function of experience. As can be seen, the most substantial difference with experience is the number of "3" statements made.

Insert Table 2 about here

The reliability of the ratings assigned to the statements was checked by having two independent raters rate a randomly chosen 100 of the 809 rated statements. Any pair of raters tended to agree about 60% of the time, but at least two of the three agreed in 96% of the cases. Again, this analysis was done with neither training nor discussion, and the potential exists for considerably

better reliability.

The Role of Experience

Table 3 was produced by totalling all the rating points assigned to respondents in each experience level for each of the seven broad divisions of the schema, and then converting to percentages. The results have been dubbed "relative emphasis", in deference to the fact that whether the ratings on the 4-point scale measure quality or quantity is a debatable point. Some slight trends can be seen across experience levels: more experienced subjects talked slightly more about the problem solving process; they spent more time on general personnel issues, and less on the librarian specifically. Of note is the fact that the three categories of the community, the school system, and the school received less than 10% of the emphasis.

Insert Table 3 about here

Further trends related to experience can be found by examining emphasis in the detailed schema as a function of experience. Table 4 gives a breakdown of total rating points by experience for those categories that showed interesting differences across experience levels, as judged subjectively. Under Problem Solving, the first pair of entries, 1.2.1.1 and 1.2.1.2, shows that less experienced subjects preferred to think problems through alone, while those with more experience preferred to brainstorm. The next pair of entries demonstrates that the Veterans related many incidents from their personal pasts, but did not reflect on the value of experience as much as the Seasoned group. The third pair of entries display that inexperienced respondents were quick to recognize that information was needed, but that they did not have the strategies available from

experience. Finally, the last pair of entries shows that less experienced (i.e., more recently trained) subjects elected more to develop action plans for themselves and ownership of problems for their staffs.

Insert Table 4 about here

The entry under category 4, The School, is included to show how little attention was paid by most respondents to the existence of a vice-principal in the school. Under the Library, Table 4 includes figures showing that less experienced subjects tended more to refer to the provincial library policy, that they were more willing to diagnose the problem, and that they tended to see professional development for the entire staff as part of the solution to the problem. The lack of attention to staff professional development by the two more experienced groups is, in fact, remarkable.

Under category 6, Personnel, the more experienced people spoke much more about how a new principal ought to establish him/herself in a school, about planning for meetings, and about team building. Finally, while most respondents said something about finding out how Miss MacDonald feels about things, those with more experience emphasized this more. On the other hand, those with less experience spoke more of her professional development.

The Role of Expertise

As part of the project, three professors of educational administration were given summaries of the transcripts and asked to rate each performance on a 10-point scale. The summaries were in the respondents' own words, but gave only the actions taken and immediately surrounding text. Only summaries were provided due to the length of the transcripts; with the actual reading of the case study text

removed, the responses run to some 200 single-spaced pages. Based on the mean ratings, the five lowest scoring and five highest scoring subjects were selected. The lowest scoring were three Novices and two Veterans, while the highest scoring were two Novices and three Seasoned principals.

Table 5 shows ratings for selected categories for these ten individuals. Categories from the schema were selected for Table 5 if at least three subjects from one group had an entry for that category, balanced by at most one subject from the other group. Although the criteria for selecting entries differ between Tables 4 and 5, it appears that differences across rated expertise are substantially larger than those across experience. An examination of Table 5 shows that substantial differences between those solutions judged high and low can be seen in problem diagnosis, in how a strategy would be developed, in the approach to the library holdings and timetable, in the emphasis placed on getting to know people, and in the handling of Miss MacDonald. These categories appear, at least in part, to capture some of the elements of expertise displayed by the subjects in this study.

Insert Table 5 about here

Table 6 offers another perspective on the differences between those transcripts scored high and those scored low. Measured in numbers of statements, the transcripts of the subjects rated low were only 62% as long as those rated high. This is reflected in the number of issues (from the schema) covered and the depth of coverage. Table 6 shows the numbers of statements at each rating level for the ten individuals in question. Although differences in the groups exist in all four rating categories, the largest difference is for level 3,

"synthesizing several ideas with evidence of thought". These data as well capture an important difference between those rated high and those rated low in solution strategy.

Insert Table 6 about here

Summary and Discussion

This study arose from ongoing research into the analysis of complex problem solving in general, and principals' problem solving in particular. Earlier work had demonstrated the feasibility of applying schema theory, in the form of a hierarchical category system, to such data. However, this earlier analysis also demonstrated that such a system became unwieldy before sufficient differentiation between categories. The proposed solution, an application of Biggs and Collis' (1982) work, has been successful. The combination of schema analysis and rating of statements within each category of the schema has enabled identification of factors separating the experienced from the inexperienced, and those judged as performing well from those not so judged. As well, although not discussed above, detailed examination indicates that factors differentiating subjects on the experience dimension differ from those differentiating them on the expertise dimension.

Several issues raised in earlier work and in this study warrant summarizing and discussion:

First, case studies differ from real-life problems; the most noticeable differences centre on recognition of and strategies for collection of missing information;

Second, the analysis developed is at least partially context dependent; understanding of the extent of this dependence would be enhanced by the study of true novices (our team is currently analysing data produced by pre-service student teachers) and by further investigation of other problems;

Third, the reliability of such analytic processes needs to be further examined; because of the size of the data set, the development and application of the schema was an iterative process, and reliability may have suffered;

Fourth, the warm-up, fact-finding, and debriefing aspects of the data collection strategies were necessary to insinuate the subjects into the world of Miss MacDonald; further attention to the problem of differential adherence to think-aloud instruction is required;

Fifth, this attempt to produce a rating scale for responses produced a variable amalgam of a qualitative and a quantitative scale depending on the category; it was easier to be eloquent when discussing the role of the library than how to build a better library collection; the extent to which this is a major issue requires further examination;

The implications of this study are both theoretical and practical. Theoretically, the issue addressed by this study is whether schema theory in combination with a rating scale, as adapted, can capture the essentials of responses to complex social problems. The results show this to be the case. Application of such methods to substantial data sets is possible, and results are encouraging.

Practically, the paper raises the question of whether these methods can be applied to assessment of outcomes of schooling. Certainly, there appears no reason why these methods cannot be applied to written as well as verbal student

output. At issue is whether approaches to ill-structured problems based on cognitive analysis can make contributions to measurement similar to those made in the context of more limited tasks (Snow and Lohman, 1988). If we assume that teachers routinely make distinctions of the precision required for the categorization reported, then the questions that require pursuit centre in the short term on how cognitive science might be applied to develop better marking schemes, and in the long term on how such approaches might contribute to the development of machine-marking of verbal material.

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Appendix A

Miss MacDonald -- A Case Study

Please assume the role of Pat Jones in the following case. Please read out loud and verbalize your thoughts as you go, then continue thinking out loud until you have gone as far as you feel you reasonably can in handling this problem.

Sugar Maple P.S. is an eighteen room elementary school (grades JK - 8) located in a lower-middle class area of a small city. The building is rather old; it was built as a high school and was remodelled extensively to accommodate the elementary school. Pat Jones was appointed principal in August and during the first few days in the school, before opening in September, Pat visited the library, which is located upstairs at one end of the building. Pat noticed that not only were the library quarters quite small but there appeared to be few modern or new books likely to meet the interests of the older students. During the first week of school Pat suggested to Miss MacDonald, the school teacher-librarian, that she drop into the office to talk about the library.

Before the meeting Pat Jones had time to check into some of Miss MacDonald's background and found that she was starting her fifteenth year as school librarian; there were instances of personality clashes with other teachers; the grade 7 teacher said that her students did not use the library as there were few suitable books; the part-time secretary assigned to the library no longer worked there since a "blow-up" had occurred over whether or not she should erase pencil marks from the books; and toward the end of the previous year, Miss MacDonald had requested to be transferred from the library to a classroom in another school.

When Miss MacDonald came in for their meeting, Pat Jones told her that she had not received her transfer because she had submitted her request too late, but that if she made her request earlier this year there might be a good chance that it would be granted. Pat's philosophy is that professionals should be free "to run their own show", and that Miss MacDonald should feel that she had a free hand. Pat expressed the hope, however, that the library would operate for the benefit of staff and students with students encouraged to use the library for individual research projects. Miss MacDonald was highly nervous and restless; her sole comment was that her main problem was the large number of books stolen each year. Pat Jones suggested that possibly she would like to use part of the next staff meeting to discuss with the staff ways in which the library could be used. Miss MacDonald remarked that she did not like talking at staff meetings and, as she backed out of the office, she mentioned that she would send out a form on which teachers could indicate their preference for their scheduled library periods.

Two weeks later, Miss Green, a first year teacher with a grade seven class, complained to Pat Jones that Miss MacDonald had told her not to leave her children unattended in the library. Miss Green felt that this was unfair because Miss MacDonald was telling other teachers when they came to library period, "to take a prep period and have coffee." She felt she needed extra preparation time as much as anybody. Pat Jones told Miss Green that library periods were not intended for teacher preparation periods; the school had a Partners in Action

program in place, and classroom teachers were supposed to be working together with the librarian to plan the use of the library resources as part of the total program. Miss Green looked a little sheepish, but left the office obviously dissatisfied. Pat Jones was concerned that the library problem was bigger than it originally looked, and determined to do something about it immediately.

At the next staff meeting, Pat Jones introduced the topic of the library. Several teachers, apparently representing the majority, declared that there was nothing wrong with the library or the way it had always operated. A few felt that, although they valued the scheduled library periods, they would appreciate more freedom to send individuals and small groups to the library for special projects and assignments. Miss MacDonald expressed concern about who would supervise these students and went on, in an obviously emotional state, to express her belief that there should be more co-operative projects between teachers and librarian; she felt that staff members were not making use of her services; sometimes she felt she was not earning her salary. Someone asked her what she meant by co-operative projects; someone else asked for examples of services she could offer to staff. Miss MacDonald, who was extremely nervous by now, was unable to answer. One of the older staff members suggested, in a friendly way, that Miss MacDonald should consider taking a leadership training course.

The meeting ended very soon thereafter, with no agreements or decisions made.

You are Pat Jones. How will you handle the situation? Please think out loud as you consider this situation and your reactions to it.

Appendix B

A Narrative Version of the Schema¹

Most subjects spent some time talking about the problem at the most global level (1). They chose to speak about the "true nature" of the problem (1.1), and often about their own problem solving processes and preferences (1.2). Some felt that it was a symptom of underlying issues such as morale (1.1.1), others that it was several problems (1.1.4), and still others that it was a straightforward and localized issue (1.1.5). Some felt that more data were needed to determine if there really was a question to be addressed (1.1.2), while others felt either that something needed to be done, or that the wrong action could make things worse (1.1.3). Those who spoke of the problem solving process talked generally of how they planned for action (1.2.1), of the role past experiences play in their problem solving (1.2.2), of the importance of information and how to get it (1.2.3), or of the development of action plans and/or subproblem identification (1.2.4). Some spoke of developing staff ownership of problems as a basic strategy (1.2.5).

A few respondents related the problem to the wider community (2) and school system (3). Some expressed a lack of information about the community (2.3), while others thought that community or student input to the library operation would be desirable (2.1). Some traced the library problems to a deterioration in community morale (2.2). In the context of the school district, a couple of subjects asked about board policy (3.1), and a similar number talked of consulting with their colleagues (3.2). Most of the references to the school system, however, were calls for support staff assistance (3.3 and 3.4).

About half the respondents made some reference to the wider school context of the problem (4). These responses were of four kinds, concerning school goals (4.1), school atmosphere (4.2), the timetable (4.3), and the role of the vice-principal (4.4).

All of the subjects dealt with the remaining three categories of the schema, the library (5), personnel (6), and the librarian herself, Miss MacDonald (7). The statements concerning the library fell into three categories, defining the role of the library (5.1), discussing present practice (5.2), and improving the library operation (5.3). Those dealing with the role of the library talked of their own expectations (5.1.1), provincial policy (5.1.2), and finding out what the staff expected of a library (5.1.3). Those who discussed present practice either diagnosed on the basis of information given (5.2.1) or outlined further information they might need and how they would get it (5.2.2). The discussions of library improvement focused on policy implementation (5.3.1, the largest category), the library collection (5.3.2), organization and procedures (5.3.3), the location and appearance (5.3.4), or the image of the library (5.3.5).

Statements concerning the staff were categorized into four larger areas: gaining entry as a new principal (6.1), building trust and avoiding conflict

¹The bracketed numbers refer to the elements in Table 1

(6.2), running a successful staff meeting (6.3), and, the largest, staff development (6.4). The entry issues were either diagnosing the difficulties the principal in the case caused him or herself (6.1.1) or outlining how to get to know people better (6.1.2), both personally and professionally. The discussions of trust and conflict were either comments on the importance of the issue (6.2.1) or specific strategies for practice (6.2.2). Discussion of meeting strategies were either explanations of what went wrong in the case (6.3.1) or strategies for doing a better job (6.3.2). The largest personnel category, staff development, fell into five sub-categories: team building (6.4.1) and leadership development (6.4.2), causing change (6.4.3), dealing with Miss Green, the case study character who had the blow-up with the librarian (6.4.4), and the problem of older, entrenched teachers (6.4.5).

The last section of the schema dealt with the librarian herself, Miss MacDonald (7), and was divided into four major sections, diagnosis of the problem (7.1), further data collection (7.2), dealing with her request for a transfer (7.3), and supporting her towards improvement (7.4). The diagnoses were positive or neutral (7.1.1), negative (7.1.2), or concerned with the possible causes of her request for a transfer (7.1.3). Further data collection involved asking her about her personal feelings (7.2.1) or her plans for the library (7.2.2). Some decided they would ask others about her (7.2.3), and others felt they wanted to observe her in action or examine her files (7.2.4). The responses to her request to transfer were to get her out for her own good (7.3.1), to remove her for the good of the school (7.3.2), or to remove her only after possible remediation had failed (7.3.3). The discussion of support fell into four categories: personal support and confidence building (7.4.1), help with interpersonal skills (7.4.2), improvement of library skills (7.4.3), and development of her leadership potential (7.4.4).

Table 1

Elements of a Schema for the Miss MacDonald Case Study

1 PROBLEM SOLVING

- 1.1 Definition of the problem
 - 1.1.1 Problem has underlying issues
 - 1.1.1.1 problem with past administration
 - 1.1.1.2 symptom of communication or morale
 - 1.1.2 There may not be a problem. What is it?
 - 1.1.3 no or poor actions may have consequences
 - 1.1.4 several problems
 - 1.1.5 library or a personnel-within-library problem
- 1.2 Problem solving process
 - 1.2.1 Planning
 - 1.2.1.1 need for perspective, time, visualization
 - 1.2.1.2 brainstorming, evolution of plans
 - 1.2.2 Role of Experience
 - 1.2.2.1 reflections on role of experience
 - 1.2.2.2 specific incident from past
 - 1.2.3 Role of Data
 - 1.2.3.1 data collection strategies
 - 1.2.3.2 data required
 - 1.2.4 Problem Elements
 - 1.2.4.1 set some priorities, action plan
 - 1.2.4.2 identify or tackle bits
 - 1.2.5 Staff Involvement
 - 1.2.5.1 develop ownership
 - 1.2.5.2 delegate, share

2 COMMUNITY

- 2.1 Seek community and student input to library
- 2.2 Build community morale
- 2.3 Investigate nature of community

3 SYSTEM

- 3.1 Ask about board policy or procedure
- 3.2 Consult with colleague
- 3.3 Bring in library resource
- 3.4 Ask about personnel resource

Table 1 (cont'd)

4 SCHOOL

- 4.1 School goals
 - 4.1.1 Jointly establish school goals
 - 4.1.2 Set expectations
- 4.2 Atmosphere of school
 - 4.2.1 Improve
 - 4.2.2 Examine
- 4.3 Timetabling
 - 4.3.1 Improve
 - 4.3.2 Examine
- 4.4 Vice-Principal
 - 4.4.1 Set expectations with/for
 - 4.4.2 Get info from or use

Table 1 (cont'd)

5 THE LIBRARY

- 5.1 Role of the library
 - 5.1.1 State specific expectations (incl. PIA)
 - 5.1.1.1 State disagreement with own show
 - 5.1.1.2 State agreement with own show
 - 5.1.2 State Partners in Action policy
 - 5.1.3 Seek input of staff expectations
- 5.2 Present practice
 - 5.2.1 Diagnosis of present practice
 - 5.2.1.1 Problem, Miss M
 - 5.2.1.2 Problem, older staff
 - 5.2.1.3 Problem, Miss G
 - 5.2.1.4 Problem, school or administration
 - 5.2.2 Data gathering, present practice
- 5.3 Improvement
 - 5.3.1 Policy implementation
 - 5.3.1.1 Initiate demonstrations and examples
 - 5.3.1.2 Scheduling and compromise
 - 5.3.1.2.1 Imposed
 - 5.3.1.2.2 Negotiated
 - 5.3.1.3 Staff professional development
 - 5.3.1.3.1 Principal owned
 - 5.3.1.3.2 Staff owned
 - 5.3.1.4 Miss M plans and ideas
 - 5.3.1.4.1 Required to staff
 - 5.3.1.4.2 Requested to principal
 - 5.3.1.5 Active principal leadership

Table 1 (cont'd)

- 5.3.2 Holdings
 - 5.3.2.1 Discuss inventory, culling, budget history
 - 5.3.2.2 Increase holdings
 - 5.3.2.3 Tie to needs or interests
- 5.3.3 Organization
 - 5.3.3.1 Theft
 - 5.3.3.1.1 Discuss
 - 5.3.3.1.2 Improve procedures
 - 5.3.3.2 Get secretarial/volunteer assistance
- 5.3.4 Location and appearance, school plant
 - 5.3.4.1 Noting
 - 5.3.4.2 Changing
- 5.3.5 Image improvement

6 PERSONNEL

- 6.1 Entry, data gathering and rapport
 - 6.1.1 Diagnosis
 - 6.1.1.1 lateness
 - 6.1.1.2 unfamiliarity
 - 6.1.2 Strategies
 - 6.1.2.1 Familiarizing (personal)
 - 6.1.2.2 Interviewing (professional)
- 6.2 Conflict, trust
 - 6.2.1 Importance
 - 6.2.2 Strategies
- 6.3 Staff meetings
 - 6.3.1 Diagnosis
 - 6.3.1.1 Miss M on the spot
 - 6.3.1.2 Bad meeting
 - 6.3.2 Strategies
 - 6.3.2.1 Plan, have data
 - 6.3.2.2 Other
- 6.4 Staff development and supervision
 - 6.4.1 Team building
 - 6.4.2 Leadership development
 - 6.4.3 Change
 - 6.4.3.1 Time comments
 - 6.4.3.2 Encourage
 - 6.4.3.3 Build from example
 - 6.4.3.4 Build from key staff
 - 6.4.4 Miss G
 - 6.4.4.1 Neutral and positive diagnoses
 - 6.4.4.2 Negative diagnoses
 - 6.4.4.3 Data required
 - 6.4.5 Entrenchment (incl. Miss M when appropriate)
 - 6.4.5.1 Diagnoses
 - 6.4.5.2 Strategies
 - 6.4.5.2.1 Develop
 - 6.4.5.2.2 Move

Table 1 (cont'd)

7 MISS MCDONALD

7.1 Diagnosis

7.1.1 Neutral or positive

7.1.2 Negative

7.1.3 Transfer request

7.2 Data collection

7.2.1 Feelings & perceptions from Miss M

7.2.2 Library plans from Miss M

7.2.3 Skills & problems from others

7.2.4 Observations, files

7.3 Transfer resolution

7.3.1 Soon, supportive reasons

7.3.2 Soon, program reasons

7.3.3 Only after remediation

7.4 Support

7.4.1 Happiness and confidence

7.4.1.1 From self

7.4.1.2 From others

7.4.2 Group and interpersonal skills

7.4.3 Library skills

7.4.3.1 Non-specific

7.4.3.2 In-school specific

7.4.3.3 Visits & conferences

7.4.3.4 Use of authority

7.4.4 Leadership development, ownership

Table 2

Summary of Statement Ratings by Experience Level (Numbers of Statements)

Rating	1	2	3	4
Experience Level				
Aspirants	38	126	38	6
Novices	36	110	43	11
Seasoned ¹	36	103	61	9
Veterans	46	101	34	11
Total	156	440	176	37

¹Note: there were only seven respondents in this group; all other groups had eight.

Table 3

Emphasis on Global Schema Categories by Experience Level
(Percentages of Total Rating Points)

Experience Level	1	2	3	4
Schema Category				
Problem Solving	14	14	17	18
Community	2	1	1	2
System	1	1	3	1
School	2	3	3	3
Library	28	32	22	16
Personnel	21	20	25	28
Miss MacDonald	31	29	28	22

Table 4

Selected Schema Elements by Experience Level (Total number of Rating Points)

	Experience Level			
	1	2	3	4
1. Problem Solving				
1.2.1.1 need for perspective, time, visualization	11	4	2	5
1.2.1.2 brainstorming, evolution of plans	0	0	7	8
1.2.2.1 reflections on role of experience	3	2	16	2
1.2.2.2 specific incident from past	4	7	11	16
1.2.3.1 data collection strategies	3	0	8	3
1.2.3.2 data required	11	6	3	3
1.2.4.1 set some priorities, action plan	7	7	3	1
1.2.5.1 develop ownership	2	10	2	2
4. School				
4.4.2 Get info from or use v-p	2	3	0	0
5. The Library				
5.1.2 State Partners in Action ¹ policy	13	14	8	5
5.2.1 Diagnosis of present practice				
5.2.1.1 Problem with Miss M	2	12	0	0
5.2.1.2 Problem with older staff	8	4	0	2
5.3.1.3 Staff professional development				
5.3.1.3.1 Principal owned	11	7	1	0
5.3.1.3.2 Staff owned	2	7	0	0
6. Personnel				
6.1.2 Entry Strategies				
6.1.2.1 Familiarizing (personal)	8	2	10	12
6.1.2.2 Interviewing (professional)	5	9	13	8
6.3.2 Staff meeting strategies				
6.3.2.1 Plan, have data	2	3	12	9
6.4.1 Team building	1	2	3	10
7. Miss MacDonald				
7.2 Data Collection				
7.2.1 Feelings & perceptions from Miss M	9	7	17	9
7.4 Support				
7.4.3 Library Skills				
7.4.3.2 In-school specific	8	9	4	3

¹Partners in Action is the Ontario school library policy document.

Table 5

Selected Schema Elements for Individuals Scored High and Low

		Low					High				
		1	2	3	4	5	1	2	3	4	5
1.1.1.2	Symptom of morale		4					2	3		1
1.1.4	several problems		1		2	3					1
1.1.5	library only problem						3	2		1	
1.2.4.1	priorities, plans		2				4	1			3
1.2.4.2	identify or tackle bits						2	3			3
5.3.1.2.2	Negotiated timetable			2			4			2	3
5.3.2.1	Discuss library holdings				2			1		3	2
5.3.2.2	Increase library holdings				2		2		2	3	2
5.3.2.3	Tie library holdings to needs				3		4		3	2	
6.1.2.1	Personal familiarization					4		2	3		3
6.1.2.2	Professional familiarization				2		3	3	2	2	2
6.4.1	Team building	1		1		3					
7.2.1	Feelings from Miss M				2		2	2	2	3	3
7.2.4	Observe, get data from files							2	2	2	
7.3.3	Move only after remediation						3	2		3	
7.4.1.1	Personally support Miss M					1	3	4		3	
7.4.2	Develop Miss M's social skills		2				4			3	2
7.4.3.3	Visits & conferences			2			1	2	2	3	
7.4.4	Leadership, ownership						4		3	2	1

Table 6

Numbers of Statements at Each Rating Level by High and Low Subjects

Rating Level	1	2	3	4
Low Subjects				
1	7	11	2	0
2	2	8	2	1
3	5	9	2	0
4	1	13	4	0
5	9	8	7	2
Mean	4.8	9.8	3.4	0.6
High Subjects				
1	3	11	8	7
2	6	21	10	1
3	4	10	10	0
4	3	18	13	2
5	6	14	7	2
Mean	4.4	14.8	9.6	2.4